Public Health Confronts the Mosquito

SPECIAL CONSIDERATIONS FOR UNITED STATES TERRITORIES AND FREELY ASSOCIATED STATES

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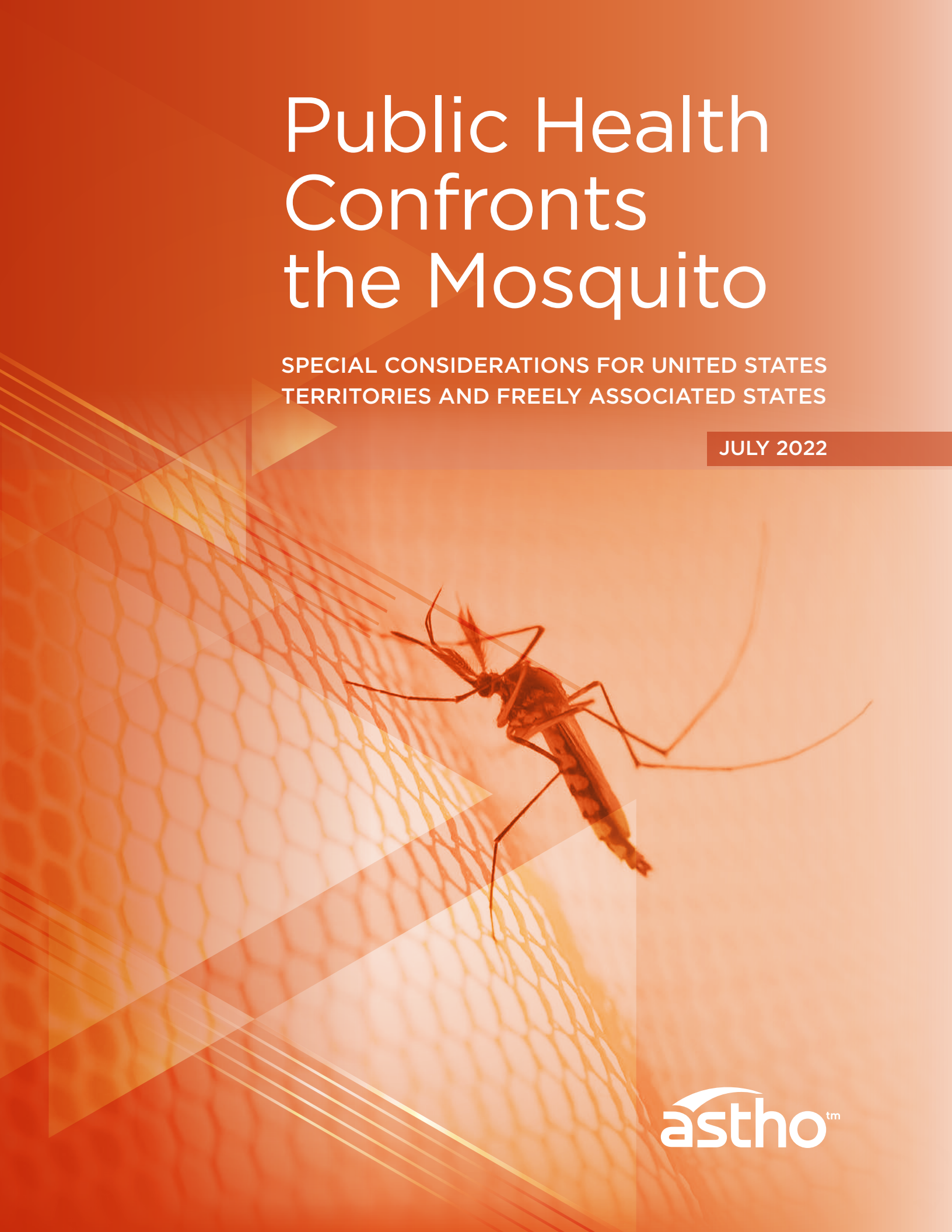

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Public Health Confronts the Mosquito: Special Considerations for United States Territories and Freely Associated States

Introduction and Background

ASTHO's previous report Public Health Confronts the Mosquito (PHCM), describes the key components needed for a mosquito control program, including proper planning, building relationships, and public support, and using the best science. PHCM, like other ASTHO reports including Technologies for Vector- Borne Disease Surveillance and Effectively Communicating About Mosquito Control Guide, offers strategies and techniques that, while certainly relevant and implementable in the U.S. territories and freely associated states, referred to collectively as the Island Areas (IAs), they suggest approaches and programs most easily replicated in state health agencies.

This report aims to highlight the unique challenges faced by IAs and to dive into the key components of a mosquito control program, as explained by PHCM, that are relevant to IAs. Two case studies of regional IA efforts to control mosquito-borne diseases (MBD) illustrate the special workforce and resource challenges IAs face in developing mosquito control capacity, as well as how IAs have built relationships and public support.

ISLAND AREAS include the Caribbean islands of Puerto Rico (PR) and the U.S. Virgin Islands (USVI) and the U.S.-Affiliated Pacific Islands (USAPIs) that include the territories of American Samoa, Guam, the Commonwealth of the Northern Marianas Islands (CNMI), and the freely associated states of the Federated States of Micronesia (FSM), the Republic of Palau, and the Republic of the Marshall Islands (RMI).

Mosquito-Borne Disease Threats Specific to Island Areas

The recent emergence and outbreaks of diseases caused by mosquito-borne viruses in IAs illustrate the different MBD-related risks IAs face compared to other areas of the continental United States (CONUS).

Cases of Zika, dengue, and chikungunya in IAs are predominately due to local transmission, while CONUS cases of the same diseases are predominantly travel-related. Zika first emerged in FSM in 2007, many years before the first locally transmitted case in CONUS. PR experienced a public health crisis of 37,000 reported Zika cases compared to the peak of 224 locally transmitted cases in CONUS. From 2010-2014, PR and USVI reported more than 29,000 locally acquired dengue cases compared to 3,014 dengue cases in CONUS, mostly travel-related.

In contrast, transmission of West Nile virus (WNV) shows the opposite pattern. WNV is a zoonotic pathogen that first emerged in CONUS in 1999, quickly spread across the country and is now endemic, but has not as severely impacted the IAs.

Environmental and Social Factors Contributing to MBD Disparities in IAs

Although USAPIs vary significantly from IAs in the Caribbean, all IAs have many shared needs and characteristics that differ from those of their state counterparts. IAs are more likely to share commonalities of remote, tropical climates and unique cultures. Their governance systems differ from their CONUS-based peers, but under the United States federal government, IAs qualify for funding for many federal agency programs, including those for MBD. These include, but are not limited to, assistance from the Regional Centers of Excellence in Vector-Borne Diseases, Zika supplemental funding, and the Office of Insular Affairs Discretionary Financial Assistance.

IAs face unique socio-economic challenges both externally and within island. A major external challenge is the lack of voting representation in Congress. Additional challenges within each IA include low-wage jobs, economies highly dependent on tourism, communication barriers due to multiple languages/dialects, and transportation limitations, especially for isolated islands within some IAs' jurisdictions that are reachable only by boat. Low-wage jobs don't retain health department staff, communication barriers make it hard to communicate with the public about vector-borne disease (VBD), and transportation limitations make it hard to reach islands for VBD control measures. These challenges make MBD control and prevention difficult.

ENVIRONMENTAL FACTORS

A primary task of most IA programs is to control *Aedes* mosquitoes, the vectors for Zika virus (ZIKV), dengue virus (DENV), and chikungunya virus (CHIKV). Unlike most states at temperate latitudes that experience cold winters that curtail mosquito activity and due to annual tropical depressions, hurricanes, and typhoons, IA mosquito control programs are busy all year, allowing no reprieve. This requires dedicated health agency staff who can work on VBD programs and funds that can be allocated to those programs.

Effective management and control of *Aedes* mosquitoes is complex. Public education and engagement are critical in eliminating *Aedes* larval habitats, including containers and other standing water around homes. These challenges amplify when protocols that were successful in the past prove ineffective due to increasing insecticide resistance problems in *Aedes* mosquitoes. To understand

resistance, staff must perform regular insecticide resistance testing on field-collected mosquitoes in laboratory settings. This testing requires specialized training and the ability to rear mosquitoes from immatures to adults in laboratories with adequate containment. Such expertise and facilities are not always available in all IAs.

Finally, the increasing impact of climate change disproportionally affects low-lying islands, especially as extreme rain events and rising sea levels create opportunities for standing water, both on the ground or in containers, perfect larval sites for certain mosquito species. For example, American Samoa experiences local transmission of lymphatic filariasis, not present in CONUS. Lymphatic filariasis is mainly transmitted by *Aedes polynesiensis,* which utilizes domestic and natural containers, like tree-holes, for larval habitat.

Despite these challenges, some environmental factors are advantageous to mosquito control in IAs. USAPIs have lower diversity of mosquitoes compared to other areas of CONUS and have no history of local outbreaks of zoonotic mosquito-borne encephalitic diseases that affect CONUS such as West Nile virus disease, St. Louis encephalitis, or eastern equine encephalitis. The absence of outbreaks of these diseases in IAs has been attributed to a lack of key vector or host species. IAs also lack vectors responsible for most tickborne pathogens present in CONUS.

SOCIAL FACTORS

Multiple social factors affect views of MBDs in IAs versus CONUS. Unlike states with modern sanitary landfills and recycling programs, IAs have traditionally relied on open dumping on vacant lands and ocean coves. Discarded used tires and other solid waste collect water and provide added larval habitat for *Aedes* mosquitoes.

Just as for sub-populations in CONUS, culturally-specific outreach and education are critical in IAs. One- size-fits-all outreach methods and materials may have limited success. For example, some populations do not recognize mosquitoes as a public health threat and instead perceive MBDs such as dengue as an unavoidable, inconsequential part of life, similar to views of seasonal colds and the flu in many other areas of the United States. In these instances, health agencies must tailor their approach to the community and work closely with local leaders to develop innovative behavior change and prevention strategies to eliminate mosquito larval sites around homes. In the past, island-wide cleanup campaigns have been effective at raising awareness about these issues in both the Caribbean and USAPIs.

CURRENT CAPACITY/ADDITIONAL FACTORS

In addition to environmental and social factors, there are also new workforce challenges. Retention of trained staff and maintenance of functional equipment and infrastructure are critically important for effective mosquito control programs. Too often, training and supplies arrive from various federal partners during outbreak response to MBDs, but surveillance and control capacity generally wanes as other environmental health priorities and public health emergencies emerge between outbreaks, leaving IAs vulnerable to future introductions.

More information about mosquito control programs in the USAPIs is described in an upcoming Technical Manual from the Pacific Island jurisdictions. Each island, both in the Pacific and Caribbean, presents unique technical challenges, cultural challenges, and resource limitations for effective mosquito control and outreach.

BUILDING RELATIONSHIPS AND PUBLIC SUPPORT

As identified in PHCM, building relationships and increasing public support are key components of an effective mosquito control program. Continued community and stakeholder support are crucial for programs in reaching more of the public and tapping additional resources. Two organizations that assist IAs in achieving and maintaining these key components are the Pacific Island Vector Management Council (PIVMC) and the Puerto Rico Vector Control Unit (PRVCU) (also known as Unidad de Control de Vectores de Puerto Rico). Both organizations provide examples of successful models for improving mosquito control in IAs by building relationships and increasing public support.

Case Studies

PIVMC CASE STUDY

Compared to state and local mosquito control programs, many USAPIs lack the infrastructure and resources for adequate and sustained mosquito surveillance and control. To address these mosquito control challenges, the Pacific Island Health Officers Association (PIHOA) generated the Regional Vector Management Strategic Plan (hereafter referred to as the Regional Plan)[1]. The Regional Plan, endorsed collectively by the USAPIs, works to support individual jurisdictions' efforts to address the threats of VBD and establish a coordinated regional approach to maintain capacities between outbreaks and prevent MBDs from spreading between islands or to other areas.

The PIVMC is organized into three tiers: (1) a board, (2) members—including vector management supervisors and staff—and (3) partners from government agencies, academic institutions, and other non-governmental organizations. Coordination and collaboration among the board, members, and partners occur during monthly online meetings and routine consultations with individual USAPI members. The Council supports the implementation of the Regional Plan. This Plan acknowledges the responsibility of each jurisdiction to keep its own vector control plan and outlines how these individual efforts can be more effective and sustainable through regional collaboration.

The Plan provides a blueprint for a cost-effective USAPI mosquito surveillance network and describes the specific equipment and supplies needed by each jurisdiction for conducting mosquito management. The Plan also describes the infrastructure and workforce challenges to sustaining an

[1] Brown, G. (2018) "Pacific Island Vector Management Improvement: A Strategy and Its Implementation"

effective surveillance program. As part of the Regional Plan framework, on-site and remote trainings help increase vector management capacities to prevent and respond to disease outbreaks.

Successful implementation of the Regional Plan relies on collaboration. For example, CDC and PIHOA were able to coordinate the procurement and shipment of vector surveillance (traps, batteries, tubes, microscopes, etc.) and control (pesticides, mist-blowers, personal protective equipment) equipment and supplies to each of the USAPI jurisdictions. The Council currently focuses on providing jurisdictions with the knowledge on how to operate and maintain the equipment, providing workshops to train staff how to identify mosquito species for surveillance, and offering training to test for pesticide resistance.

PRVCU CASE STUDY

The PRVCU is an initiative of the Puerto Rico Science, Technology, and Research Trust funded through a cooperative agreement with CDC. When originally implemented, PRVCU supported mosquito control efforts for both Caribbean IAs. It currently provides support to PR by offering workforce training, sharing surveillance data, supporting systems to manage these data, and providing expertise on mosquito control technology to government, non-government, and municipal programs.

PRVCU supports an integrated vector management (IVM) approach to mosquito control, informed by surveillance data and reliant on an informed, engaged public. Within PRVCU, the Monitoring and Surveillance Team conducts field surveys of mosquito populations, submitting samples to PRVCU's laboratory for identification, virus testing, and insecticide resistance testing. The Community Mobilization Team educates residents on how to control larval habitats around their homes, conducts outreach to high-risk areas, and promotes partnerships and advocacy for controlling mosquitoes and MBD.

The high number of DENV, ZIKV, and CHIKV cases in PR and USVI relative to USAPIs and locally transmitted cases in CONUS demonstrates the need for these PRVCU programs. PRVCU mosquito surveillance data show that the dengue virus is widespread in mosquito populations across PR and that DENV risks may be higher than indicated by case reports. Traditional approaches to controlling DENV vectors have lacked the IVM techniques promoted by PRVCU.

PRVCU collaborates with CDC and the Ponce Health Sciences University to bring this IVM approach to the local level in Ponce, PR. Another project of PRVCU, Communities Organized to Prevent Arboviruses (COPA), enlists residents in fourteen zones in Ponce to participate in collecting field data on mosquito abundance and participate in household visits for clinical data collection on the prevalence of MBD. Each year, approximately 3,500 residents receive diagnostic testing for DENV, ZIKV, and CHIKV.

Funding Vector-Borne Disease Surveillance and Control

While one-time or crisis funding can help jurisdictions respond to immediate threats from emerging MBDs, sustained funding is needed to prevent or rapidly contain future emerging vector-borne disease for all jurisdictions. The absence of dependable, dedicated federal funding streams for mosquito control is particularly challenging for IAs, which often lack the local mosquito control programs present in most states. No IA has the equivalent of a mosquito control district supported by dedicated tax revenue.

Several regional and international public health consortiums support MBD efforts in IAs. Though not exhaustive, some groups supporting MBD control through funding, training opportunities, or workforce assistance in USAPIs include World Health Organization Western Pacific Regional Office, Indo-Pacific Centre for Health Security, and the Pacific Southwest Center for Excellence in Vector-Borne Diseases. PR and USVI participate in regional initiatives, including the Caribbean Public Health Agency, the Pan American Health Organization (within WHO), and the Southeastern Center of Excellence for Vector- Borne Diseases.

COVID-19

COVID-19 dramatically impacted the management of MBD resources globally. COVID-19 response demanded that surveillance and laboratory services expand and that resources previously devoted to MBD pivot to address this pandemic. As demands for pandemic response declined, resources became available for MBD surveillance. The additional investments in laboratory capacity for pandemic response present unique opportunities for IA mosquito surveillance programs. For example, the Belau National Hospital in Palau used COVID-19 funding to develop a PCR testing capacity for clinical samples. This capability can also be used to analyze field mosquito samples for viruses that cause MBDs.

Building the public health workforce needed to respond to COVID-19 and other emerging infectious diseases, including MBD, requires recruiting qualified entry-level staff, training and retaining skilled workers, and accessing appropriate expertise through collaboration. MBD disparities between IAs and states reflect the magnitude of these workforce challenges in IAs, additionally impacted by low wages, limited educational opportunities, and lack of entomological expertise.

Opportunities to Apply Innovative Mosquito Control Methods in IAs

The IAs offer unique opportunities to conduct innovative mosquito control trials, because of their location and island topography. Incompatible insect technique (IIT) using *Wolbachia*-carrying males and sterile insect technique (SIT) both hold promise for mosquito control in IAs, especially for islands where a single vector mosquito species predominates.

Practical barriers to implementation of these techniques include the remoteness of islands making it impossible for timely delivery of materials and/or mosquitoes to be released. Implementation would require building a mosquito rearing facility at a central location (e.g., Guam) and shipping from there. Constructing and maintaining a rearing facility is cost-prohibitive unless additional sources of funding can be identified.

As part of the COPA project, in August 2020, the PRVCU began evaluating a new method of mosquito control, IIT, using male mosquitoes with *Wolbachia*. Every week, PRVCU released male *Ae. aegypti* mosquitoes that are infected with *Wolbachia* into study zones set up in Ponce, PR. When the released males mate with wild *Ae. aegypti* females, no offspring are produced. Researchers wanted to determine whether these releases can succeed in reducing the numbers of wild *Ae. aegypti* mosquitoes over time. Researchers also monitored the number of dengue, chikungunya, and Zika cases in study zones to see if they differ from cases reported outside the study zones.

Conclusion

The updated, second edition of Public Health Confronts the Mosquito offers guidance on maintaining a capable and effective mosquito control program for meeting the challenges of VBD. Recommendations include effectively planning for addressing the needs of both routine operations as well as emergencies, building relationships and bolstering stakeholder support, and employing a solid understanding of control strategies and prevention methods.

All these recommendations are founded on reliable funding, sound science, a trained workforce, and an informed public, which are essential components of successful mosquito control programs for both IAs and CONUS. However, IAs face a variety of unique and interrelated environmental and social challenges that must be considered when offering guidance. For example, IA health agencies must identify strategies for building health agency capacity with a highly transient workforce—a less prevalent challenge for many state health agencies. Similarly, most state/territorial health agencies do not face the same burden of immediate climate threats to public health and many IAs currently depend on external, patchwork, and sporadic support for their mosquito control programs.

The IAs have developed important regional partnerships and strategies for addressing VBD, as described in the two case studies above. By illustrating the unique challenges and needs IAs face in developing mosquito control capacity, it is clear that more sustained commitments must be made to prepare for and prevent MBD outbreaks in the Caribbean and Pacific regions.

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